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STEREOMICROSCOPE OR ADDITIONAL ELEMENT FOR A STEREOMICROSCOPE

The invention relates to a stereomicroscope or to an additional element for a stereomicroscope with the ability to switch between different observation modes of which one is a stereoscopic observation mode through a stereo lens and the other a binocular monoscopic observation mode through a compound lens, the stereo lens and the compound lens being rotatably supported in a switching device in the stereoscopic beam path, and a prism arrangement being provided which during observation through the compound lens combines the two beam paths to form a single beam path.

Such a stereomicroscope is described in US-A1-2002/0034001 of 3.21.2002 (publication date). The known stereomicroscope comprises - in the direction of an observation beam path - a binocular tube and an automatic prism displacement mechanism with a binocular beam splitter that can be displaced by means of a control cable for the purpose of linking the binocular tube with either both stereoscopic observation beam paths or with just one of the two observation beam paths. Said stereomicroscope also comprises a microscope body accomodating the stereoscopic observation beam paths and a switching device rotatably supported on a microscope holder for a microscope body. The switching device holds a stereo lens and two compound lenses.

The microscope body, in turn, is supported on a focus-adjusting mechanism so as to be displaceable in a direction oblique to the observation beam paths. The displaceability is required to be able, in the use position, to place both the stereo lens and each compound lens centrally over the object. Because the compound lens comes to rest underneath one of the two stereo observation beam paths, however, such a displacement must amount to one-half the distance between the axes of the observation beam paths when it is desired to position the observation beam in the two observation modes relatively equally to the object. In the use position, all cited lenses are thus parcentric and parfocal. The displacement of the microscope body on its focus-adjusting mechanism is brought about by a gear that automatically causes the displacement as a function of the position of the switching device. The gear, in turn, is connected to the control cable which in turn acts on a lever mechanism with which the binocular beam splitter can be displaced.

The known microscope thus involves a complicated design with two gears and a cable connection between them. The microscope is also integrally configured, to the extent that it shows *a priori* this functionality of the switchable observation possibilities and that it cannot give up this functionality and thus the gears, the binocular beam path splitter and the displaceability relative to the focus-adjusting mechanism – namely that to achieve this

functionality a conventional stereomicroscope can only be reconfigured but not retrofitted. In other words, this prior art does not relate to an additional element for a stereo-microscope.

Moreover, control cables are components that are not thought to be particularly reliable so that, for example, optionally they must be readjusted or serviced.

The known microscope is provided with a fluorescence excitation illumination which makes it possible to make both stereoscopic observation and fluorescence observation through a compound lens. Here, in the case of incident fluorescent light excitation, the fluorescent light passes through the right partial stereo beam path. This can be disadvantageous, because in this beam path autofluorescence phenomena can occur or such phenomena must be prevented by use of special measures. In particular, the induced fluorescence illumination reduces the contrast reflection of the fluorescent object. Although a second fluorescence excitation illumination is also provided, this illumination is directed onto the object as transmitted light illumination via a stand base of the micro-scope and is not available for incident light illumination.

Another prior art is the following:
EP-B1-170857 describes a microscope with a binocular tube wherein by means of a compound lens it is possible to switch a stereomicroscope from normal stereoscopic observation to binocular observation. The drawback of such a configuration is that it does not allow compensation for a misalignment when during binocular observation the object field is changed to an object field under stereoscopic observation. To this extent, this prior art is less appropriate from a practical standpoint than is the solution according to the afore-said prior art with automatic compensation of a misalignment. This known configuration provides no solution for observations in fluorescent light.

Although EP-B1-170857 thus also discloses a stereomicroscope with a switching device for a compound lens and a stereo lens on a stereomicroscope, said switching device is not provided with a gear and does not allow automatic compensation for the mis-alignment. Furthermore, this known configuration is not provided with a displaceable carrier. For the known stereomicroscope, the motivation for mounting the binocular beam splitter above the compound lens was therefore rather in the area of chance and in that case did not serve the purpose of solving a drive problem, because the known stereo-microscope, in view of the absence of a drive, does not present such a problem. In view

of this, it was therefore not obvious to mount the binocular beam splitter between the carrier and the compound lens, in accordance with the invention. Moreover, a solution takeover from EP-B1-170857 would have lost its parcentricity so that a mere takeover of the known arrangement not only was not obvious but would not have led to the desired result.

EP-B1-167926 also reveals a binocular tube microscope that permits lateral displacement of an optical system carrier so that the axis of the lens can be brought into coincidence with the axis of a zoom channel. From this prior art, too, no teaching can be derived concerning an improvement of the first-said prior art. Regardless of this, both cited EP-B1 documents are more than fifteen years older than the first-said prior art (US-A1-2002/0034001) so that a person skilled in the art is, in view of the first-said prior art, kept from looking for improvements over this prior art in such a distant past.

EP-A1-1010030 discloses a system for stereoscopic observation in incident fluorescent light with a particularly advantageous third zoom channel through which the illumination beam path is guided. This system suppresses the disturbing autofluorescence, but does not provide a basis for selectively observing objects through a stereo lens or through a compound lens.

On the basis of this described prior art, the invention has for a main object to improve the known first-said microscope so that it will be more compact. In particular, it is to have fewer gears, no control cable or the like and, hence, should have a more robust and simpler configuration. It would be particularly preferred if the configuration needed for the afore-mentioned functionality could be retrofitted as an additional element for conventional stereomicroscopes. It would also be preferred if the microscope - including the known microscope - could be used as a fluorescence microscope, but with illumination guidance improved in a manner such that autofluorescence could be reduced by simple measures.

The main objective is reached through the features of claims 1, 2 and 27. Refinements of the subject matter of claim 1 lead to further improved microscopes and, in particular, also provide solutions for the other objects. According to claim 2, this main objective is also reached in the case of a microscope with incident illumination in that, while the switching system and the devices connected thereto are retained, the beam path for the illumination is also incorporated in integrated fashion.

In the sense of the invention, the terms used in this application can be explained as follows. By stereomicroscope is meant both a surgical microscope and a conventional stereomicroscope. By binocular tube is meant a conventional binocular tube as well as an assistant's binocular tube or a binocular connection to an image-uptaking device. A binocular beam splitter is a beam splitter that photo-optically combines the binocular observation beam paths with a single partial beam path of a stereoscopic microscope beam path and, for example, can be configured as a mirror or prism. Frequently, however, it is used as a binocular splitter prism. In particular, the invention comprises the use of a Y-prism so that, if necessary, the need for displacement or a displacement mechanism or a gear is eliminated. A Y-prism in the sense of the invention is a beam splitter with two entering beams and one emerging beam, with all three beams being in the same plane and the axis of the emerging beam path coinciding with the symmetry axis of the two entering beam paths.

The use according to the invention of such a Y-prism, however, would make it necessary for the axes of the observation beam paths and of the lenses - in the use position - to be in the same plane. By use of other prisms, it is possible to displace the axis of the compound lens to the side in the plane defined by the axes of the two observation beam paths so that the design can be more compact or so that more space can be provided for an illumination beam path.

By microscope body is meant a three-dimensional component that accommodates the observation beam paths of the stereomicroscope and any separate illumination beam paths that may be present. In most cases, the beam paths accommodate at least one zoom. All zooms are preferably coupled either mechanically or electrically.

A switching device or a displacement device according to the invention is mounted rotatably or displaceably on the holder and comprises a rotary bearing or at least one guide rail as a well as a plate with supports on which there is disposed or can be fastened at least one stereo lens and at least one compound lens. Preferably, said device is provided with latches or the like so that it can be fixed in a preferred position or can be used when desired.

By focus-adjusting mechanism is meant a mechanical or motorized mechanism whereby the microscope body can be displaced in the focus direction (Z-direction) relative to a stand and thus relative to an object.

By compound lens is meant a lens with relatively large magnification through which, as a result of the binocular beam splitter, both observation beam paths are guided congruently toward each other. To improve brightness, a refinement can be provided at the binocular beam splitter making it possible to remove said splitter from the beam path as desired with the result that the observer looks through only one of the stereoscopic beam paths.

By a gear is meant a device that transfers the movement of a component or a position of a component to another component. Within the framework of the invention, such a gear can be mechanical, motorized, pneumatic, hydraulic, electric or electronic. In any case, the transfer occurs automatically. The purpose of actuating the switching device is to save the observer the effort to have to reposition the lens after he or she had switched lenses.

In a particular embodiment, according to the invention, the displacement of the microscope body in this case takes place in the X and Y directions to compensate for a misalignment of the lens axis relative to the plane formed by the two axes of the observation beam paths. This means according to the invention that the displacement path of the carrier is longer than one-half the distance SB between the two axes of the observation paths.

Alternatively, such a gear could displace not only the microscope body but also the lens or the lens carrier. This, however, would cause the object to move, which perhaps would be undesirable. Such a conceivable variant could not be used in surgical microscopes, because they do not have an object carrier.

According to the invention, therefore, the parts needed for the switching between the modes of observation - and particularly also for use under fluorescence conditions - are disposed in a single component group. The switching or displacement of the switching device alone is sufficient to bring about the change from stereoscopic to binocular observation. The novel configuration allows retrofitting of conventional stereomicroscopes and particularly of conventional fluorescence stereomicroscopes without causing stray light components to appear.

In a particular embodiment, according to the invention, the coupling-in of illumination in the region of the compound lens takes place through a flat component group that is pushed in obliquely to the axis of the compound lens. As a result of this configuration, the

coupling into the component unit consisting of the compound lens and binocular beam splitter can be achieved in a compact manner. Moreover, the mounting of such a flat component unit of the invention involves only a minor fabrication cost.

The beam splitter for coupling in the illumination can be solidly built in as a neutral-gray splitter, because, through the filter module, the exciter filter and blocking filter can already bring about the desired fluorescence of the fluorescence microscope (cf., for example, EP-A1-1010030).

The beam splitter for coupling in the illumination can also be configured as a dichroic beam splitter. Independent switching between the exciter-blocking filter and the dichroic splitter provides greater flexibility in terms of fluorescence excitation and fluorescence observation.

Other refinements based on a microscope as defined in claim 1 or 2 give rise to the following effects or advantages, among others:

A rigid connection between the binocular beam splitter and a mount for the compound lens results in a more compact construction. The effect of this is that the binocular beam splitter and the lens can be moved simply and at the same time and are thus spatially always in optimum orientation relative to one another.

Because the lens mounts and the focal lengths of the lenses are always subject to tolerances, it is advantageous that the compound lens comprises a fine-focusing device, and particularly that during the switching from the stereo lens to the compound lens the operator's hand is there.

Retrofitting ability is optimized when the switching device and the gear form a single assembly unit with lenses, binocular beam splitter, holder, carrier and displacement device.

Preferably, the stereo lens is laterally adjustable so as to establish parcentricity with the compound lens, because the mount and the lens holders can be subject to tolerances.

If illumination coupling-in is provided between the compound lens and the binocular beam splitter, then incident-light illumination can be used also in the compound observation

mode. The invention is preferably to be applied in fluorescence stereomicroscopes in which the light source for the illumination beam path is an exciting light source with a certain exciting light frequency, for example UV, so that the blocking filters are preferably disposed on the microscope body and/or in the binocular beam splitter. Optionally, the blocking filters are already disposed under the microscope body or in the lower region thereof, because in this manner the observation beam paths can be kept free of exciting light over long distances, which in the prior-art microscopes is not possible.

As is known per se, the invention comprises a filter turret or a filter drawing device for different filter applications in fluorescence microscopy. In this regard, the reader is referred to the figures and figure descriptions in EP-A1-1010030 where particularly suitable filter holders are described. The figures and figure descriptions in the cited patent are hereby incorporated into the present patent application by reference. The same applies to the filter construction of the prior art, US-A!-2002/0034001.

With a fluorescence stereomicroscope according to EP-A1-1010030, the advantages of the configuration preferred according to the invention lie in a separate third illumination channel, in an advantageous filter arrangement and in an optimum utilization of the lens pupil for observation beam paths and illumination beam path as a result of the displacement of the lens axis toward the symmetry axis of the observation channels.

The objectives are reached through the afore-described invention and the variants thereof.

The reference symbol list and the drawings, together with the objectives described in the claims or with the protected subject matter are an integral part of the disclosure of this patent application.

The invention will now be explained in exemplary and non-restricting manner by reference to the drawings.

The figures are described in linked and overlapping fashion. Equal reference symbols mean equal components, and reference symbols with different indices refer to components with the same function.

The drawings show the following.

Fig. 1 shows the symbolic overall configuration of a microscope of the invention:

Fig. 2 shows a front view of a schematic representation of the observation beam paths 3a, 3b, and an illumination beam path 34 with a stereo lens 6 put into position;

Fig. 3 shows a side view of the representation of Fig. 2;

Fig. 4 shows a schematic representation of the observation beam paths 3a, 3b, and of the illumination beam path 34 in side view with compound lens 7 put into position;

Fig. 5 shows a schematic representation of the observation beam paths 3a, 3b when the compound lens is put into position;

Fig. 6 shows a schematic representation of the displacement of the carrier relative to the holder;

Fig. 7 shows a schematic configuration of a gear with a crank mechanism 35 and a cam 36 in cross-section;

Fig. 8 shows a schematic configuration of a gear with two gear wheels 23a, 23b, and a gear rack 24;

Fig. 9 shows a schematic configuration with a Y-prism 2b which makes it possible to eliminate the need for displacing carrier 12 as long as the axis of compound lens 7 coincides with the symmetry axis of both observation beam paths 3a and 3b.

Fig. 1 shows symbolically and schematically the overall configuration of a microscope of the invention. It comprises - in the direction of an observation beam 27 - a binocular tube 1, an incident light illumination system 28 and a microscope body 4 that accommodates the stereoscopic observation beam paths 3a, 3b (which coincide with the observation beam 27) and an illumination beam path 34. Microscope body 4 is held by a carrier 12 which permits displacement in the X and/or Y direction obliquely to the observation beam paths 3a, 3b and is disposed on an L-shaped microscope holder 14. Said holder in turn is supported via a focus-adjusting mechanism 9 disposed on a stand 13 and permitting

displacement in height. A switching device 5 holds a stereo lens 6 and a compound lens 7 which can be selectively swivelled in front of the stereoscopic observation beam paths 3a, 3b in the microscope body 4. The switching device 5 is fastened via rotation axis 30 to L-shaped holder 14.

The switching device is needed to be able to center stereo lens 6 as well as compound lens 7 over object 8. Because, however, as a result of the arrangement the binocular beam splitter 2a, compound lens 7 ends up being positioned below one of the two stereoscopic observation beam paths 3a, 3b, such a displacement of carrier 12 must occur over a length equal to one-half the distance between the axes of the two observation beam paths 3a, 3b, when one wants to position observation beam path 27 relatively equally with respect to object 8. Thus, in the use position all said lenses 6 and 7 are parcentric and parfocal. The displacement of carrier 12 of microscope body 4 relative to holder 14 is brought about by a gear 10 which automatically causes the displacement to take place depending on the position of switching device 5. Located ahead of compound lens 7 are a focus-adjusting device 11, an illumination coupling-in system 15 and a binocular beam splitter 2a. Illumination coupling-in system 15 makes it possible to couple the illumination light from an illumination beam path 34 into compound lens 7 for incident light illumination of objective 8 (Fig. 3).

Fig. 2 shows schematically the optical details of beam paths 3a, 3b, 34 in microscope body 4 with stereoscopic lens 6 placed in position as in Fig. 1. Filters 19a and 19b serve in the known manner as exciter and blocking filters under conditions of fluorescence observation. Beam path 3a indicates the left observation beam path the axis whereof is indicated by a dot-dash line and 3b indicates the right observation beam path the axis of which is shown as a dash-dot line. Both beam paths run through filter 19b and zoom systems 16a, 16b, and by means of stereo lens 6 are focused on object 8. Moreover, an illumination beam path 34 is indicated by its axis. Said path passes through a filter 19a and a zoom 17 and by lens 6 is also focused on object 8.

Although, for better representation, all zooms 16, 17 are shown in one drawing plane one next to each other, illumination beam path 34 optionally lies in a plane different from that of observation beam paths 3a, 3b, and in a top view would partly cover said paths. Zooms 16a, 16b, 17 are - preferably and as per se known - linked to one another mechanically or electrically.

Fig. 3 shows a side view of the configuration according to Fig. 2 from which it can be seen that the axis of observation beam path 3b and thus also that of observation beam path 3a lie in a common plane. The axes of observation beam paths 3a, 3b and the axis of illumination beam path 34 are parallel to the axis of lens 6. All axes 3a, 3b, 34 are separated by a distance from one another. The distance between the two observation beam paths 3a and 3b is indicated in Fig. 6 by SB. The axis of lens 6 lies in a plane with respect to which the two observation beam paths 3a, 3b are mirror-symmetric.

Fig. 4 is a side view of the schematic representation of the optical details of the microscope according to Fig. 1 with the compound lens 7 placed into position. The axis of the illumination beam path 34 is shown as a dash-dot line. The illumination beam path 34 which originates at the light source 18 is switched by a switching element, for example by a mirror 20, and passes through an exciter filter 19a and zoom 17 and enters the coupled-in illumination 15. In said illumination, a mirror 42 guides the beam path onto a beam splitter 43 which congruently combines illumination beam path 34 with observation beam path 31 (which coincides with the emerging beam path 3c) of compound lens 7.

Fig. 5 shows the front view of the configuration in the position according to Fig. 4, from which it is also possible to see the configuration of binocular beam splitter 2a. As can be seen, compound lens 7 is disposed in the prolongation of left observation beam path 3a. To compensate for the dislocation relative to the position of stereo lens 6, microscope body 4 or the carrier thereof 12 must be displaced to the left (X-direction) - in the plane of the drawing - for one half the distance between the axes of observation beam paths 3a, 3b. Other displacements - perpendicular to or across the plane of the drawing (Y-direction) - are advantageous or necessary when the axis of the stereo lens 6 is not in the plane of the two observation beam paths 3a, 3b and/or when the binocular beam splitter 2 causes a beam displacement also in the Y-direction.

Fig. 6 shows the misalignment path Vs consisting of two misalignment components Vsx and Vsy. A line here shows the effective direction 40 that is to be reached as a result of the displacement. Effective direction 40 is disposed toward the two observation beam paths 3a, 3b at an angle α to the plane passing through the two observation beam paths 3a, 3b that are disposed at a distance SB from one another.

Fig. 7 shows the possible use of a gear 10a according to the invention that is provided with a crank mechanism 35 having crank pin 37 and cam 36, said cam 36 being rotatably

held in holder 14 and the crank pin 37 engaging into a longitudinal groove 38 of carrier 12. A journal 41 of cam 36 is rigidly connected with a switching device (turret) 5 so that a rotation of the turret actuates the cam 36. Depending on the effective direction 40, this actuation brings about the displacement of carrier 12 over the distance Vs.

Such an arrangement permits a rotation of 360°.

In Fig. 8 is shown a comparable configuration but without crank mechanism 35 and, instead, provided with gear wheels or pinions 23a and 23b, gear wheel 23b being provided only optionally. Gear wheel 23a is driven by switching device 5 and rotated through 180°. If the circumference thereof is dt = 2s, the desired displacement Vs is achieved by moving gear rack 24 in the effective direction 40.

List of Reference Symbols

1	Binocular tube
2a	Binocular beam splitter
2b	Y-prism
3	Stereoscopic observation beam paths
	3a - left partial observation beam path
	3b - right partial observation beam path
	3c - beam path emerging from beam splitter 2a and combining in itself partial observation beam paths 3a, 3b
4	Microscope body
5	Switching device
6	Stereo lens
7	Compound lens
8	Object
9	Focus-adjusting mechanism
10	Gear
11	Fine-focusing mechanism
12	Carrier
13	Stand
14	Holder, microscope holder
15	Illumination coupling-in device
16 a, b	Zoom in observation beam path 3a, 3b
17	Zoom in illumination beam path 34
18	Light source
19a	Filter, exciter filter
19b	Filter, blocking filter
20	Switching element, mirror
20 a, b	Gear wheel or pinion
24	Gear rack
27	Observation beam
28	Incident-light illumination system
30	Rotational axis
31	Observation beam path of the compound lens
34	Illumination beam path
35	Crank mechanism
36	Cam

37	Crank pin
38	Longitudinal groove
40	Effective direction
41	Journal
42	Mirror, switching element
43	Beam splitter
Vs	Misalignement
Vsx	Misalignement component in the X-direction
Vsy	Misalignement component in the Y-direction
SB	Distance between the axes of the observation beam paths 3a, 3b.